REMARKS

Applicants have amended their claims in order to further clarify the definition of various aspects of the present invention. Specifically, Applicants have amended previously considered independent claims 17 and 18 to be dependent on newly added claims 47 and 48. As discussed further infra, claims 47 and 48, and claim 33, are the only independent claims in the application.

Claim 47 defines a fuel cell assembly including a unit fuel cell and a humidifier. The humidifier includes a water-retaining layer for retaining water therein, made of hydrophilic porous material; a water permeable layer in face-to-face contact with the water-retaining layer, the water permeable layer being made of a hydrophilic porous material that passes water, but not gas; a separator having a gas channel facing the water permeable layer on one face and facing a unit fuel cell on the other face; and a holder for holding peripheries of the water-retaining layer, water permeable layer, separator, and unit fuel cell, the holder, which is partitioned from a gas channel with a wall member, is provided, with a water flow channel therein to exclusively supply water to the water-retaining layer.

New independent claim 48 also defines a fuel cell assembly including a unit fuel cell and a humidifier. The humidifier includes a water-retaining layer for retaining water therein, this water-retaining layer being made of hydrophilic porous material; a separator having a gas channel facing a water permeable layer on one face and facing a unit cell on the other face; a filter made of a hydrophilic porous material disposed between a water channel and the water-retaining layer; and a holder for holding peripheries of the water-retaining layer, water permeable layer, separator and unit fuel cell, the water-retaining layer supplying water to gas passing

in the gas channel to humidify it, and wherein the holder, which is partitioned from a gas flow channel with a wall member, is provided with a water channel therein, to exclusively supply water to the water-retaining layer, supplying the water thereto via the filter.

Note that claims 47 and 48 include recitations set forth in, for example, previously considered claims 2, 4, 13, and 16.

In light of newly added claims 47 and 48, Applicants have cancelled claims 2, 4, 13, 16, 25, 28 and 31 without prejudice or disclaimer, and have amended dependencies of various of the previously considered claims. In addition, Applicants have cancelled claims 19, 22, 24, 30, 44 and 45 without prejudice or disclaimer, and have amended dependencies of various of the other previously considered claims.

Applicants have amended claims 17 and 18 to be dependent respectively on claims 47 and 48, with claims 17 and 18 being further amended in light of recitations in claims 47 and 48, respectively.

Applicants have amended claim 33 to incorporate therein the subject matter of claims 38 and 39, and, moreover, to recite that the flow channels for flowing gases are partitioned with a wall from the channel containing water; and to recite that the porous water-retaining layer is in communication with a channel containing water by way of a filter for passing water, but not gas, the channel containing water exclusively supplying water to the water-retaining layer, supplying the water thereto via the filter. In light of amendments to claim 33, claims 38, 39, and 44 have been cancelled without prejudice or disclaimer, while dependency of claim 43 has been amended.

Entry of the present amendments is clearly proper, in view of the concurrent filing of the RCE Transmittal; and it is respectfully submitted that the present amendments constitute the necessary Submission under 37 CFR 1.114 for this RCE Transmittal.

The objection to claim 4 set forth in Item 2 on page 2 of the Office Action mailed November 17, 2008, is moot, in light of present cancelling of claim 4.

Applicants respectfully traverse the rejections of claims 8, 19 and 46 under the first paragraph of 35 USC 112, as failing to comply with the written description requirement. Claim 19 has been cancelled without prejudice or disclaimer; accordingly, the rejection thereof as set forth in Item 5 on page 3 of the Office Action mailed November 17, 2008, is moot.

With respect to the rejection of claims 8 and 46, note that these claims have been amended to be dependent on claims 48 and 33, respectively. Claim 48 recites that the fuel cell assembly includes a filter between the water channel and the water-retaining layer; and, similarly, claim 33 recites that the porous water-retaining layer is in communication with a channel containing water by way of a filter for passing water, but not gas. Thus, each of claims 33 and 48 recites structure including the filter between the water channel and the water-retaining layer; in connection therewith, note Fig. 5. Claims 8 and 46 further define the filter, as shown in, for example, Fig. 5. Noting especially Fig. 5, it is respectfully submitted that claim 46, dependent on claim 33, clearly is disclosed in Applicants' original disclosure, in the structure of, e.g., Fig. 5.

With respect to the subject matter claimed in claim 8, Applicants respectfully traverse the conclusion by the Examiner that the specification does not disclose a

structure that includes both a water permeable layer and a carbonaceous porous filter. In connection therewith, and while not to be limiting, attention is respectfully directed to page 25, lines 17-19 of Applicants' specification, describing that with the use of the porous carbon filter 501, the water permeable membrane 201 of Embodiment 1 can be omitted, as the porous carbon filter 501 can control the flow rate of part of the cooling water from the cooling water flow channel to the water-retaining layer 203. It is respectfully submitted that this description would have shown that while the water permeable membrane 201 of Embodiment 1 "can be omitted" when using the porous carbon filter 501, such water permeable membrane 201 need not be omitted; and, accordingly, it is respectfully submitted that the description in Applicants' disclosure as a whole shows that Applicants contemplated as part of their invention a fuel cell assembly including both the water permeable layer and the porous carbonaceous filter, as of the filing date of the above-identified application. Accordingly, it is respectfully submitted that the description requirement of the first paragraph of 35 USC 112 has been satisfied.

Applicants respectfully submit that all of the claims presented for consideration by the Examiner patentably distinguish over the teachings of the documents applied by the Examiner in rejecting claims in the Office Action mailed November 17, 2008, that is, the teachings of the US patent documents to Kanazawa, Patent Application Publication No. 2003/0087982, and to Yi, Patent Application Publication No. 2002/ 0004501, and the following foreign patent documents: JP 07-135012 (Mizuno), JP 08-138704 (Kawazu '704), and JP 08-138705 (Kawazu '705), under the provisions of 35 USC 102 and 35 USC 103.

It is respectfully submitted that these references as applied by the Examiner would have neither disclosed nor would have suggested such a fuel cell assembly as in the present claims, including the recited unit fuel cell and humidifier, and with the humidifier including, inter alia, a water-retaining layer for retaining water therein, this layer being made of hydrophilic porous material; and a holder for holding peripheries of the water-retaining layer, a water permeable layer, a separator, and a unit fuel cell, with the holder, which is partitioned from a gas flow channel with a wall member, being provided with a water channel therein to exclusively supply water to the water-retaining layer. See claim 47; note also claim 48, reciting supply of water to the water-retaining layer via the filter.

In addition, it is respectfully submitted that these applied references would have neither disclosed nor would have suggested such a fuel cell assembly as in the present claims, having a plurality of fuel cell units and a humidifier, wherein the humidifier includes, inter alia, a porous water-retaining layer which is in communication with a channel containing water by way of a filter for passing water, but not gas, this channel containing water exclusively supplying water to the water-retaining layer, supplying water thereto via the filter. See claim 33; note also claim 48.

In addition, it is respectfully submitted that the applied references would have neither disclosed nor would have suggested such a fuel cell assembly as in claims 47 and 48, having features as discussed previously in connection with these claims, and, moreover, wherein the humidifier also includes a water permeable layer in face-to-face contact with the water-retaining layer for humidifying gas in the gas channel of a separator, this water permeable layer being made of a hydrophilic

porous material that passes water, but not gas, and a separator having a gas channel facing the water permeable layer on one side and facing the unit fuel cell on the other (see claim 47); and/or wherein the humidifier further includes a separator having a gas channel facing a water permeable layer on one face and facing the unit fuel cell on the other face, with a filter made of a hydrophilic porous material being disposed between the water channel and the water-retaining layer (see claim 48); or wherein the fuel cell assembly includes a plurality of fuel cell units in such a relation that the water-retaining layer faces the flow channels thereby to transfer water introduced into the water-retaining layer to the fuel and/or oxidizing gas flowing in the flow channels, the flow channels for flowing gas being partitioned with a wall from the channel containing water (see claim 33); note also claims 47 and 48, reciting that the holder is partitioned from a gas flow channel.

Furthermore, it is respectfully submitted that these applied references would have neither disclosed nor would have suggested such a fuel cell assembly as in the present claims, having features as discussed previously in connection with claim 33, and, moreover, wherein the filter is a porous carbonaceous filter (see claim 46).

As discussed in more detail infra, it is respectfully submitted that the teachings of the applied documents do not disclose, nor would have suggested, such structure as in the present claims, including wherein the humidifier has a water-retaining layer and a holder provided with a wall member such that the water channel in the holder exclusively supplies water to the water-retaining layer; and, moreover, the holder being partitioned from a gas flow channel to avoid, e.g., direct transfer of water from the water channel to the gas flow channel.

Moreover, it is respectfully submitted that the teachings of the applied references would have neither disclosed nor would have suggested such fuel cell assembly as in the present claims, having features as in independent claims 33, 47 and 48, as discussed previously, and additionally having features as set forth in the dependent claims, such as (but not limited to), the size and porosity of the water permeable membrane respectively as in claims 5 and 6, and material of the water permeable membrane as in claim 7; and/or wherein the porous member has a hydrogen-oxidizing catalyst dispersed therein (note claims 41-43); and/or a power generation system including, inter alia, the fuel cell assembly of claim 47, as in claim 11; and/or porosity and thickness of the water-retaining layer as in claims 17 and 18; and/or wherein the fuel cell assembly has at least two water-retaining layers (see claim 20); and/or wherein the carbonaceous porous filter controls flow rate of water to the water-retaining layer (see claim 21); and/or wherein the water-retaining layer is a material as set forth in claim 23; and/or wherein the humidifier further includes a water permeable membrane, positioned as set forth in claim 25; and/or further definition of position of the water-retaining layer or water permeable layer as in claim 31; and/or wherein the assembly has a single humidifier (see claims 32 and 40).

The invention as claimed in the above-identified application is directed to a fuel cell assembly including unit fuel cells, and a power generation system using such fuel cell assembly. In particular, the present invention is directed to such fuel cell assembly, and such power generation system, including polymer electrolyte fuel cells.

As described on page 1 of Applicants' specification, a unit fuel cell of the polymer electrolyte fuel cell (PEFC) includes a membrane-electrode assembly having a proton exchange membrane, which is a proton-conductive membrane sandwiched

between porous electrodes, and a unit cell separator having gas flow channels which supply hydrogen gas to the anode and air (oxygen) to the cathode, respectively. The proton-conductive membrane must be kept wet to a certain level, to let protons move; and various mechanisms have been proposed as apparatus to humidify fuel gasses, as described on pages 2 and 3 of Applicants' specification. Various previously proposed humidifiers have problems such as consuming power, which reduces efficiency of the fuel cell system, and disadvantageously increasing size of the assembly.

Against this background, Applicants provide a fuel cell assembly including a humidifier, which avoids problems of previously proposed humidifiers, avoiding a reduction in efficiency of the fuel cells and avoiding an increase in the size of the assembly. The fuel cell units of the present invention are simply constructed of minimum elements, so that total volume is minimized and is fabricated at reduced cost. Furthermore, the present invention, having a minimal number (e.g., one or two) of humidifiers, is very flexible in design thereof.

According to the structure of the present invention, the channel containing water (water flow channel), e.g., of the holder, exclusively transfers water to the water-retaining layer. In addition, there is limited communication of the water-retaining layer with the channel containing water. Furthermore, the channel containing water does not transfer water to a gas passage, there being a wall member partitioning gas flow channels from the channel containing water.

In particular, it is emphasized that according to the present invention, water from the channel containing water, e.g., for humidification, is exclusively transferred to the water-retaining layer, where it is held until used when the fuel cell is operating.

This avoids various problems, including the problem of free water which may freeze in the fuel cells.

In this regard, it is important to prevent water freezing, in fuel cell assemblies as in the present invention. Fuel cells will be used for automobiles or for home power generation instruments, as disclosed, for example, on page 38, lines 2-14, of Applicants' specification. It is respectfully submitted that where the fuel cells are utilized for automobiles or for home power generation, the fuel cells should have some countermeasures for preventing water from freezing, because fuel cells for automobiles and home use likely will encounter water freezing, in various climates, at the time of stopping the fuel cells. Prevention of water freezing in the fuel cell assembly, when the fuel cell is not in use, is a common problem in fuel cells in actual use. Prevention of such freezing is an important objective in the field of fuel cells, in applying such fuel cells to actual use in automobiles and in the home.

In particular, free water in fuel cells, at the time that the fuel cells are not being operated, is a source of the freezing problem, and such free water needs to be removed in order to avoid the freezing problem. In the present invention, water is supplied to the water-retaining layer from a water flow channel in the frame of the fuel cell assembly. The water flow channel of the fuel cell is, illustratively (and not to be limiting), a manifold, as shown, for example, in Figs. 2 and 5 of Applicants' disclosure, and this water flow channel is simple in structure, compared with water passages formed in a separator for cooling water, in various previously proposed fuel cells. Since free water is present only in the manifold in the fuel cell assembly of the present invention, and not, for example, substantially in the water-retaining layer or other structure of the assembly, the water is easily removed from the manifold by

gravity, e.g., by opening a valve when the fuel cell is stopped, as shown in Fig. 6 of Applicants' disclosure, wherein water for humidification is removed from the fuel cell assembly by gravity.

In contrast, free water is present in water flow passages in conventional fuel cells. Water flow passages, for example, in a separator, have a relatively complicated structure such as a serpentine structure. In addition, the water flow passages have a small sectional area. Therefore, it is very difficult to remove water present in these water flow passages when conventional fuel cells are stopped. Such water flow passages in conventional fuel cells have horizontal and vertical portions forming a serpentine structure, leading to difficult removal of water when the fuel cell is stopped.

According to the present invention, the structure for humidification supplies water exclusively to the water-retaining layer. Such water is provided exclusively either directly to the water-retaining layer or via a filter. In any event, water from the water flow channel is transmitted and held in the water-retaining layer, and, in particular, is held therein when the fuel cell is stopped. Thus, according to the present invention, free water is avoided in the fuel cell, because free water in the water flow channel is easily removed from the fuel cell at the time that the fuel cell stops operation. Water retained in the water-retaining layer is not free water, and, hence, it does not freeze to substantially increase its volume so as to thereby cause damage to the fuel cell. That is, even if the water contained in the water-retaining layer freezes, the increased volume can be absorbed by the porous material. As a result, it is possible to avoid damage to structural members of the fuel cell, even when the fuel cell stops operation at temperatures below 0°C. Therefore, prevention

of freezing of water, and damage to the fuel cell structure caused by frozen water, can be avoided by the present invention.

In contrast, in a conventional fuel cell, where water remains in the fuel cell and freezes at the time when the fuel cell is not in operation, the frozen water becomes larger in volume and applies pressure to structural members constituting the fuel cell. As a result, the structural members may be damaged or destroyed, caused by the presence of free water in the fuel cell, particularly in the water flow passage.

Free water is not present in the fuel cell of the present invention, because the water-retaining layer absorbs any water in accordance with its absorption capacity. The water-retaining layer does not retain water beyond its absorption capacity; and, furthermore, empty pores remain in parts of the water-retaining layer absorbing any increased volume of frozen water. Therefore, the fuel cell assembly according to the present invention is not damaged by an increased volume of frozen water.

As can be seen in the foregoing, it is respectfully submitted that previously proposed fuel cells, without water being exclusively supplied to the water-retaining layer, would have neither disclosed nor would have suggested the presently claimed invention, and advantages achieved thereby.

Thus, with the structure according to the present invention, damage of the assembly, both of the humidifying apparatus and of the fuel cells, caused by free water which freezes, can be avoided.

Furthermore, according to that aspect of the present invention using a filter, the filter does not contact directly with gas, and a supply amount of water to the water-retaining layer can be controlled by the filter. This avoids free water that is not held by the micro-pores of the water-retaining layer. Since the filter does not face

directly to the gas flow channels, and since the filter does not receive any influence of gas pressure, it is possible to supply a stable humidifying amount even when gas pressure changes.

The objectives of the present invention are further achieved by utilizing the humidifier having a water-retaining layer with, e.g., a mean micro-pore diameter and thickness as in various of the present claims, particularly wherein this water-retaining layer is made of a hydrophilic porous member, and wherein this water-retaining layer is used together with a water permeable layer that faces gas flow channels of the fuel cells, and whereby water is retained by capillary force by the water-retaining layer when the fuel cells are not working, and is taken by the oxidizing/fuel gases against the capillary force when the plurality of fuel cells is working. Using apparatus (the humidifier) as in the present invention, excess humidification of the fuel/oxidizing gases can be avoided, and a simple and effective humidification of the fuel/oxidizing gases can be provided, with other advantages as discussed previously.

Moreover, through use of present structure having the water-retaining layer and the water permeable layer that faces the gas flow channels, when the fuel cells are not operating the humidifying water held in the water-retaining layer remains held in micro-pores of the water-retaining layer by capillary force, preventing the, e.g., anode gas from being humidified too much and reducing the humidity of the anode gas.

Kawazu '704 discloses a hydrogen gas humidifier constituted with a porous film, and separators which interpose the porous film from both sides and form a hydrogen gas flow path and a water flow path respectively. The porous film 111 is a polyolefin porous film and has a hydrophilic nature. This patent document discloses

that water is easily vaporized by receiving heat from both the porous film and the hydrogen gas, humidification being conducted in a state of steam.

In Kawazu '704 the porous carbon 610 contacts the gas; the porous carbon 610 is used for preventing breakage of the porous membrane 111 due to pressure differences. It is respectfully submitted that the position and function of the porous carbon in Kawazu '704 are different from those of the filter according to the present invention.

Moreover, it is respectfully submitted that Kawazu '704 would have neither disclosed nor would have suggested such a fuel cell assembly as in the present claims, wherein, inter alia, the channel containing water exclusively supplies water to the water-retaining layer, the water-retaining layer being in communication with this channel containing water by way of a filter, and advantages thereof as discussed in the foregoing.

Moreover, positioning of the porous carbon 610 in Kawazu '704 is again noted; in view thereof, the cooling water channels or gas flow channels may be clogged by the filter when portions of the filter are deformed or broken, due to conditions such as when there is an increase in pressure differential. Moreover, when freezing of cooling water takes place in the structure of Kawazu '704, the filter may be broken, and the humidifier will not work. Such problems are avoided by the present invention, including the filter as in the present claims, positioned as set forth therein. In particular, and as set forth previously, if water freezes at the filter, in the structure of the present invention, supply of water from the filter stops, thereby to prevent breakage of the water-retaining layer or water permeable layer by freezing.

Mizuno discloses a fuel gas humidifying layer constituted of a water permeable layer and a gas flow path structure. The water permeable layer comprises a film-shaped microporous film made of polypropylene, and a hydrophilic layer formed by laminating nonwoven fabric in a surface of the microporous film. In the microporous film, water is permeated in accordance with a pressure difference between both sides bordering the film.

It is respectfully submitted that Mizuno, et al. would have neither disclosed nor would have suggested the channel containing water exclusively supplying water to a water-retaining layer as in the present claims, or such structure with the water-retaining layer being in communication with the channel containing water by way of the filter, among other features, and advantages thereof as discussed in the foregoing.

In Mizuno, the structure characterized by the Examiner as the filter is adjacent the water flow path, adjacent the entirety of a main surface thereof, the entire back surface of the structure characterized by the Examiner as the filter being between the water flow path 308 and the fuel gas flow path 348. Compare with the presently claimed invention, wherein the water-retaining layer communicates with the channel containing water only by way of the filter, the filter being positioned where the cooling water inlet and the water-retaining layer communicate with each other. As stated previously, as the filter according to the present invention does not contact directly with gas, and since a supply amount of water to the water-retaining layer can be controlled by the filter, this avoids free water not held by the micro-pores. Moreover, since the filter according to the present invention does not face directly to the gas flow

channels, and since the filter is not influenced by gas pressure, it is possible to supply a stable humidifying amount even when gas pressure changes.

It is respectfully submitted that the teachings of the secondary references applied by the Examiner together with Kawazu '704, in Items 10-14 on pages 6-12 of the Office Action mailed November 17, 2008, would not have rectified the deficiencies of Kawazu '704, such that the presently claimed invention as a whole would have been obvious to one of ordinary skill in the art.

Yi, et al. discloses fuel cell power plants using a water transport plate having interdigitated flow channels therein to furnish the reactive gases to the fuel cell, the power plant being described most generally in Section [0009] on page 2 of this document. This power plant includes a cooling water stream, which is in fluid communication with both the anode and cathode support plate hydrophilic substrate layers, the hydrophilic substrate layers having both the anode and cathode support plates with a predetermined level of porosity (that is, number of pores) and pore size. Note Sections [0010] and [0011] on page 2, and Section [0014] on page 3, of this patent document. Note, in particular, Section [0039] on page 4 of this patent document, with reference to Fig. 2, further disclosing the predetermined pore size and predetermined porosity. Note also Sections [0037] and [0038] on pages 3 and 4 of this patent document. Note also Sections [0054]-[0056] on page 6, and Section [0065] on page 8, of this patent document.

Even assuming, arguendo, that the teachings of Yi, et al. were properly combinable with the teachings of Kawazu '704, such combined teachings would have neither disclosed nor would have suggested the presently claimed structure, including the water-retaining layer and holder, and wherein the holder, which is

partitioned from a gas flow channel with a wall member, is provided with the water channel therein to exclusively supply water to the water-retaining layer, and advantages thereof.

Kanazawa discloses a method to improve properties such as water absorption and adhesion, etc., of a polymeric material without lowering the practical strength of the material, through various combinations of treatments as described in Sections [009]-[0013] on pages 1 and 2 of this patent document. Note pages 3-6 for further descriptions of these various treatments.

Even assuming, arguendo, that the teachings of Kanazawa were properly combinable with the teachings of Kawazu '704 and Yi, et al., such combined teachings would have neither disclosed nor would have suggested various features of the present invention including the holder which is partitioned from a gas flow channel of the fuel cell assembly with a wall member, and which is provided with the water channel therein to exclusively supply water to the water-retaining layer, by way of the filter, and advantages thereof as discussed in the foregoing.

With respect to the claim rejections set forth in Items 13 and 14 on pages 11 and 12 of the Office Action mailed November 17, 2008, Kawazu '705 discloses a hydrogen gas humidifier constituted with a porous film, a catalyst reaction layer formed on its one side surface, and separators which interpose the porous film and the catalyst reaction layer from both sides and form a hydrogen gas flow path and a water flow path respectively. This patent document discloses that water in the water flow path permeates the porous film and the catalyst reaction layer according to a difference in pressure of water flowing in the water flow path and the pressure of hydrogen gas flowing in the hydrogen gas flow path, with permeated hydrogen gas

reversely flowing from the hydrogen gas flow path side to the catalyst reaction layer through the porous film reacting with oxygen dissolved in water by the action of the platinum catalyst.

Even assuming, arguendo, that the teachings of Kawazu '705 were properly combinable with the teachings of Kawazu '704, or the combined teachings of Kawazu '704 and Yi, et al., such combined teachings would have neither disclosed nor would have suggested the structure of the present claims, including, among other features, the humidifier comprising the water-retaining layer as defined in the present claims together with the holder, with the holder being partitioned from a gas flow channel with a wall member and being provided with a water flow channel therein to exclusively supply water to the water-retaining layer, and advantages thereof as discussed in the foregoing.

In view of the foregoing comments and amendments, and in view of the concurrently filed RCE Transmittal, entry of the present amendments, and reconsideration and allowance of all claims pending in the above-identified application, are respectfully requested.

Applicants request any shortage in fees due in connection with the filing of this paper be charged to the Deposit Account of Antonelli, Terry, Stout & Kraus, LLP, Deposit Account No. 01-2135 (case 520.43216X00), and credit any excess payment of fees to such Deposit Account.

Respectfully submitted,

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APPENDIX

Corrected Drawings
Two (2) Replacement Sheets for Sheets 2/6 and 5/6
(FIGS. 2 and 5)